PATENT SPECIFICATION (11) 1 554 645

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(21) Application No. 36852/76 (22) Filed 6 Sep 1976
(31) Convention Application No's 612605 (32) Filed 11 Sep 1975 in
612524
612607
612606
(33) United States of America (US)
(44) Complete Specification Published 24 Oct 1979
(51) INT. CL. ² H02G 5/06
(52) Index at Acceptance H2E 7E1

(54) "CONTROL CENTRE WITH INSULATED BUS BARS"

(71) We, WESTINGHOUSE ELECTRIC CORPORATION of Westinghouse Building, Gateway Center, Pittsburgh, Pennsylvania, United States of America, a company organised and existing under the laws of the Commonwealth of Pennsylvania, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates generally to control devices and, more particularly, to insulated and isolated bus bar assemblies thereof.

In the design of modern electrical equipment, the protection of personnel from accidental contact with current-carrying parts, and the protection of the equipment from damage as a consequence of short-circuit or similar fault conditions are important considerations. Existing bus bar assemblies vary considerably in design but most of them employ steel or insulating barriers arranged to protect personnel and equipment from the above-mentioned hazards. Where such conventional barriers result, as many of them do, in the formation of voids and air pockets between the bus bars and the barriers as well as between the bus bars themselves, the removal of heat from the conducting bus bars will be impeded, and ionization of such air pockets and voids can produce flashovers between adjacent bus bars of different phases, which flashovers can deteriorate into severe faults propagated from phase to phase and most likely causing severe damage to or even complete destruction of the bus bar assembly.

It is the principal object of the invention to provide a bus bar and barrier assembly which is not subject to the above drawbacks, and the invention accordingly resides in a control center comprising a cabinet containing substantially parallel spaced bus bars adapted to be connected to different phases of an external source of electric power, and which bus bars have connecting portions adapted to have connected thereto circuit interrupters placed into said cabinet, characterized in that said bus bars are sandwiched between two separate insulating barriers which have good heat transfer properties and are maintained in firm heat-transfer contact with substantially the whole surface of each bus bar facing the respective insulating barrier, at least one of said barriers having formed therein recesses which are aligned with the respective connecting portions and are just large enough to enable connection of circuit interrupters to said connecting portions, each barrier including elongate phase-isolating portions which extend longitudinally between adjacent ones of the bus bars and mesh with complementarily shaped phase-isolating portions of the other barrier to form gas-movement impeding labyrinths between said bus bars.

With this novel arrangement wherein the bus bars are sandwiched between and in firm heat transfer contact with the two insulating barriers, air pockets around the bus bars are practically eliminated and heat conduction from the bus bars to the outer surfaces of the two barriers is greatly enhanced, as is the dissipation of heat from said outer barrier surfaces which are larger than the surfaces of the bus bars themselves. In the preferred embodiment of the invention to be described more specifically later herein, good heat transfer contact between the barriers and the bus bars is maintained by at least two pairs of braces which latter extend transversely across the barriers, and which pairs are spaced apart in the longitudinal direction

of the barriers, the braces of each pair engaging the barriers from opposite sides of the bus bar and barrier assembly, and being connected together so as to clamp said assembly firmly therebetween. The surface of each brace engaging the adjacent barrier preferably conforms substantially to the profile of the latter so as to make full surface contact therewith throughout its width, and the braces preferably are formed of steel. These braces not only act as excellent heat sinks for heat conducted through the insulating barriers in contact therewith, but also lend sufficient structural strength to the whole bus bar and barrier assembly to permit the barriers to be molded from a relatively thin, sheet-like material just thick enough to provide adequate electrical insulation. The braces may also be utilized to secure the bus bar and barrier assembly to frame structure-forming part of the cabinet.

The gas-movement impeding labyrinths between adjacent bus bars isolate the latter from each other very effectively insofar as they present relatively long and tortuous paths to the flow of any ionized gas which may be present. The layrinths will normally prevent such ionized gas from reaching neighboring bus bars and, hence, from initiating electrical phase-to-phase breakdowns. Even if a fault should occur at some other point of the equipment and spread to the bus bar and barrier assembly, it will not be propagated through the latter because the labyrinths will break up the ionized stream.

In the preferred embodiment, one phase-isolating portion of each meshing pair of such portions is a rib formed on one of the barriers and protruding toward the other barrier, and the other phase-isolating portion of the same pair is a channel which is formed in said other barrier and is open toward said one barrier, the rib being seated in the channel. This particular form of intermeshing phase-isolating portions permits the spacing between the two barriers—or, in other words, the bus bar thickness and consequently the current-carrying capacity of the bus bars—to be varied, within limits, without detriment to the labyrinths.

In order to shield the bus bar connecting portions exposed at the recesses of the insulating barriers from contact with persons or objects, the or each barrier which is provided with such recesses preferably has formed thereon flanges which are disposed around the respective recesses and project from the barrier so as to provide the desired shielding. In the preferred embodiment still to be described, integral portions of at least one barrier which are aligned with flat surface portions of the respective bus bars are removable and just large enough to expose, when removed, parts of the flat bus bar surface portions enabling circuit interrupters with a bolt-on or similar type of terminal connectors to be secured thereto. At such removable barrier portions, which may be knockout portions having peripheral sections of reduced thickness so as to be removable by being "knocked out", it is desirable to provide also protective shielding flanges similar to those mentioned above.

For additional protection from accidental contact with the conductive bus bars, the recesses enabling connection of each circuit interrupter to the bus bars preferably have associated therewith a shutter which is biased toward a position wherein it covers the recesses associated therewith, and which is movable to an ineffective position in which it leaves the associated recesses unobstructed and ready for having the terminal connectors of a circuit interrupter inserted therethrough. In the illustrated embodiment, such shutter has associated therewith, and is connected to, a shutter-operating member including a cam portion which is disposed to be engaged by a circuit interrupter and thereby actuated to effect movement of the shutter to the ineffective position thereof when the circuit interrupter is being moved toward the recesses associated therewith.

A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of an electrical control center;

Figure 2A is a front elevational view of the upper half of a left hand portion of the control center (as viewed in Figure 1) with the front doors open;

Figure 2B is a front elevational view of the lower half of the said left hand portion of the control center with two of the doors open;

Figure 3A is a side elevational view of the control center as viewed in Figure 2A, with the doors closed and the side panel removed;

Figure 3B is a side elevational view of the portion of the control panel shown in Figure 2B, with the doors closed and the side panel removed;

Figure 4 is a horizontal sectional view taken on the line IV—IV of Figure 2B and showing a circuit breaker being inserted in place;

Figure 5 is a perspective view of an assembly of bus bars and insulative barriers, and of support bars for the barriers shown in exploded positions;

Figure 5A is an enlarged fragmentary view of the area encircled in Figure 5;

Figure 6 is a fragmentary horizontal sectional view showing the assembly of the bus bars, insulative barriers and support brackets in place; and

Figure 7 is a horizontal sectional view showing an assembly of the bus bars, insulative barriers and shutters therefor.

The electric control center generally indicated at 13 in Figure 1 comprises a metal cabinet having a plurality of compartments, such as compartments 15, 17, 19 and 21 (see Figures 2A—B), arranged one above the other and

separated from each other by horizontal shelves 23. The compartments have doors, such as the doors indicated in Figure 1 at 25, 27, 29 and 31, and the doors may be provided with suitable openings 33 for circuit breaker handles, such as handles 35, 37, indicator-light panels, such as panels 39, as required.

The cabinet 13 comprises a rectangular steel framework consisting of U-shaped corner posts 41 (Figure 4), horizontal interconnectors 43, 45 at upper and lower ends, vertically spaced horizontal braces 47 (see also Figures 3A—B), two upright posts 49, one at the front and one at the rear of the cabinet 13, and two support posts 51 and 53 disposed adjacent opposite side wall panels 55 and 57 of the cabinet.

In the embodiment disclosed herein, the cabinet 13, as best seen from Figure 4, has compartments similar to the compartments 15—21 formed therein both at the front and at the rear thereof, and has vertical bus bars 59, 61, 63 disposed between the front and the rear compartments such that circuit breakers similar to the circuit breaker 65 can be connected to the bus bars from both sides. As seen from Figures 2A—B and 4, in addition to the compartments 15, 17, 19, 21 to the left of the upright post 49, there is a vertically extending front compartment 67 (Figure 4) to the right of the post 49, the compartment 67 being separated from the compartments 15—21 by a partition 69 and from the central area of the bus bars by a partition 71, and extending vertically substantially for the height of the cabinet 13. The compartment 67, which has a door 73 (Figures 1, 2A—B), is provided to accommodate electrical wires from the various circuit interrupters 65 in the compartments 17, 19, 21. In the illustrated embodiment having circuit interrupter compartments at both the front and the rear of the cabinet, a vertical compartment similar to compartment 67 but designated 75 extends vertically alongside the circuit interrupter compartments in the rear, as seen from Figure 4.

As shown more particularly in Figures 2A and 3A, the upper ends of the bus bars 59, 61, 63 are attached to separate horizontal buses 77, 79, 81, respectively, by suitable fastening means, such as bolts 83. The bus bars 59, 61, 63 extend vertically in the cabinet 13 substantially for the full height thereof so that circuit interrupters 65 in all of the compartments at the back and the front of the cabinet can be connected thereto. As seen from Figures 4 to 7, the bus bars 59, 61, 63 preferably are substantially Z-shaped, each comprising a main or intermediate portion 91, and two connecting portions or blades 87, 89 spaced apart in lateral direction of the main portion and extending from the latter in opposite directions. The electrical capacity of each bus bar 59, 61 or 63 may be increased by attaching to the main portion thereof a coextensive conductive bar. As best seen from Figure 4, the arrangement of the bus bars 59-63 within the cabinet 13 is such that their main portions 91 lie in a vertical plane substantially parallel to the front and rear sides of the cabinet, and the connecting portions 87 and 89 extend toward the circuit interrupter compartments at the front and the rear, respectively, of the cabinet so as to be engageable with suitable terminal connectors or clips 93 of the circuit interrupters placed into the respective compartments. Preferably, the Z-shaped bus bars 59, 61, 63 are extruded one-piece conductors although they may be composed, if desired, each of two L-shaped members joined, e.g. bolted, to each other. As shown in Figures 2B and 3B, each circuit interrupter 65 is supported in the associated compartment by means of mounting members 66 disposed on its opposite lateral sides and cooperating with tracks 68 depending as integral portions from the adjacent horizontal shelf 23 or, if desired, secured as separate members to adjacent frame portions, such as the upright posts 41 and 49, of the cabinet 13.

The bus bars 59, 61 and 63 are sandwiched between, and in firm heat-transfer contact with, a pair of insulating barriers 95 and 97 including elongated phase-isolating portions which extend longitudinally between the respective pairs of bus bars 59, 61 and 61, 63, the phase-isolating portions of one barrier meshing with complementarily shaped phase-isolating portions of the other barrier in such manner as to form gas-movement impeding labyrinths between the bus bars, thereby to prevent dielectric breakdown between the latter such as otherwise might occur upon ionization of the spaces therebetween. In the preferred embodiment illustrated, each pair of intermeshing phase-isolating portions comprises an elongate rib portion 111 projecting from one side of one of the insulating barriers 95 and 97, and an elongate channel-forming rib portion 113 projecting from the opposite side of the other insulating barrier and having the rib portion 111 of said one barrier seated therein with a close fit. This will, within limits, permit the thickness and, hence, the circuit-carrying capacity of the bus bars to be varied without impairing the effectiveness of the phase-isolating portions.

Since, in the preferred embodiment shown, each bus bar is substantially Z-shaped having blade-like connecting portions 87, 89 which extend from the main portion 91 thereof, each insulating barrier 95 or 97 is provided, as best seen from Figures 5 and 6, with longitudinal sheath-like ribs 109 which are spaced laterally apart and substantially U-shaped in cross section so as to receive the respective blade-like connecting portions 87 or 89 of the bus bars. And since connection of circuit interrupters, such as the interrupters 65 in Figure 4, is made in the preferred embodiment by clip-type engagement of the circuit interrupter terminals 93 with the stab-like connecting portions 87 or 89 of the bus bars, recesses 99, 101 and 103 just large enough to permit such

connection to be made are formed in the sheath-like ribs 109 at the various levels where circuit interrupters are to be connected to the bus bars. In order to ensure against accidental contact by persons or objects with the bus bar portions exposed at the recesses 99, 101 and 103 in the barrier 95 or 97, each recess is surrounded on four sides thereof by vertical flange portions 115, 117 and horizontal flange portions 119, 121 projecting from the substantially planar main portion of the respective barrier 95 or 97.

In addition, at least one or both of the insulating barriers 95 and 97 may be provided with removable portions, such as the portion 129 shown in detail in Figure 5A, which removable portions are aligned with the flat main portions 91 of the respective bus bars and, when knocked out, that is, removed as facilitated by reduced sections 131 and 133, expose enough surface of the adjacent main portions 91 of the respective bus bars to allow a circuit breaker with bolt-on terminals to be bolted to the bus bars. Such bolted-on circuit breaker is shown in Figures 2A and 3A at 123 as supported on a support bracket 125 secured to the support posts 53, and as connected to the bus bars by means of connectors 127 (only one being seen in Figure 3A) secured, e.g. bolted, to the main portions 91 of the respective bus bars. In order to shield the bus bar surfaces exposed by the removal of the knockout portions 129 from accidental contact by persons or objects, the associated insulating barrier 95 or 97 has flange portions, including flange portions 135 and 137, which form hoods around the respective openings left by the removed knockout portions 129. As best seen from Figure 5A, the flange portion 117 adjacent each knockout portion 129 may also be adapted to be removed if desired or necessary in order to expose a larger surface area of the adjacent bus bar for connection of a circuit breaker terminal connector thereto.

Finally, each insulating barrier 95 or 97 preferably is provided with lateral end flanges 105 and 107 designed to cooperate with the corresponding end flanges of the other insulating barrier so as to facilitate the proper alignment and fitting together of the two insulating barriers with respect to each other.

The two barriers 95, 97 which are substantially identical in the preferred embodiment illustrated may be formed of a suitable thermosetting resinous material selected from the group consisting of polyester, epoxy, phenol and mixtures thereof. A suitable material is isophthalic maleic-glycol polyester. To strengthen the sheet-like members from which the barriers are molded, the material preferably contains an inorganic reinforcing material, such as glass fiber. In addition, the resin includes a filler selected from the group consisting of alumina, aluminum hydroxide, beryllium oxide, calcium carbonate, mica, silica, talc, and mixtures thereof. The sheet-like members from which the barriers are molded preferably have a minimum thickness of about 0.1 inch. A satisfactory commercial material suitable for forming the insulating barriers is marketed by Rostone Company of Lafayette, Indiana, United States of America, under the trademark "Rosite 3550FM".

The assembled barriers 95, 97 and bus bars 59, 61, 63 are maintained in firm surface-to-surface contact with each other and are supported in the cabinet 13 by means of two horizontal braces 139, 141 (Figures 2A, 3A, 4, 5, 6). The brace 139 is secured at its opposite ends to the support posts 53 by means of bolts 143 (see Figures 4 and 6) and the brace 141 is secured to the brace 139 by means of bolts 145 and nuts 146 (see Figures 5—6). There are provided several pairs of braces 139, 141 spaced apart vertically along the assembly of barriers and bus bars. The brace 139 comprises a bar 147, and a channel member 149 secured, e.g. welded or riveted, to the bar 147 and having therein notches 151 and 153 for receiving the sheath-like ribs 109 and the phase-isolating portion 111—113, respectively, of the adjacent barrier 95. Likewise, the brace 141 comprises a bar 155, and a channel member 157 secured, e.g. welded or riveted, to the bar and having formed therein notches 151 and 153 for receiving the sheath-like ribs 109 and the phase-isolating portion 111—113, respectively, of the adjacent barrier 97. When in place, opposite edges of the channel members 149, 157 engage the planar surfaces of the barriers 95, 97, as at 159 (Figure 6), and engage the ribs 109 and the rib portions 113 at the notches 151 and 153, respectively. Thus, with the bolts 145 and nuts 146 tightened against the braces 139 and 141, the latter clamp the assembly of insulating barriers and bus bars firmly therebetween so as to maintain excellent heat transfer contact between the bus bars and the insulating barriers, and between the latter and the braces, and also to hold the bus bars securely in place even when subject to such strong electromagnetic forces as may result under short-circuit conditions.

Upon the removal of a circuit interrupter from the cabinet 13, the associated connecting portions 87 or 89 of the bus bars become exposed in the associated recesses 99, 101, 103 of the adjacent insulating barrier 95 or 97. In order to prevent accidental contact with these exposed bus bar portions, shutter means are provided for covering the recesses 99—103 when the associated circuit interrupter 65 is removed from the cabinet. Referring to Figures 2B, 3A—B and 4, the shutter means associated with any horizontal row of recesses 99—103 comprises a shutter 161 formed of a suitable dielectric material, e.g. the same as the barriers 95, 97. The shutter 161 has several spaced openings 163 (Figure 2B), one for each bus bar, the spacing between the openings 163

corresponding to the spacing between the recesses 99—103.

As shown more particularly in Figure 5, upturned and down-turned tabs 165 and 167 are provided on the flange portions 119, 121 of the barrier for supporting and guiding the shutter 161 for horizontal sliding movement thereof. The shutter has at one end thereof a connecting portion 171 (Figures 2B, 4, 7) with an elongated slot formed therein with which is engaged one end of a rod-like shutter operating member 169, the other end of which is pivotally supported by a mounting bracket 173 secured to the corner post 41. The shutter operating member 169 has an intermediate cam portion 175 which extends into the path of travel of one side 65A of the associated circuit interrupter 65 such that, when the latter is moved into the compartment 19 and toward the assembly of bus bars and barriers, it engages the cam portion 175 and rotates the shutter operating member 169 counterclockwise, as viewed in Figure 2B, thereby moving the shutter 161 to the left to align the openings 163 therein with the recesses 99, 101, 103 in the barrier 95. This enables the terminal connectors 93 of the circuit interrupter to move into engagement with the connecting portions 87 of the corresponding bus bars. An end portion 177 of the shutter operating member 169 extends through a slot in the mounting bracket 173 and has connected thereto a spring 179 (Figure 3B) which becomes effective when the circuit interrupter 65 is withdrawn from the cabinet, to restore the shutter 161 to a shutter-closed position thereof in which the openings 163 are out of registry with the recesses 99-103 and the latter are covered by the shutter.

Preferably, the clip-on terminal connectors 93 of each circuit interrupter are of the floating type providing enough limited freedom of lateral movement thereof to permit self-alignment, and thereby facilitate engagement, of the connectors 93 with the corresponding stab-like connecting portions 87 or 89 of the bus bars 59—63.

WHAT WE CLAIM IS:—

1. A control center comprising a cabinet containing substantially parallel spaced bus bars adapted to be connected to different phases of an external source of electric power, and which bus bars have connecting portions adapted to have connected thereto circuit interrupters placed into said cabinet, characterized in that said bus bars are sandwiched between two separate insulating barriers which have good heat transfer properties and are maintained in firm heat-transfer contact with substantially the whole surface of each bus bar facing the respective insulating barrier, at least one of said barriers having formed therein recesses which are aligned with the respective connecting portions and are just large enough to enable connection of circuit interrupters to said connecting portions, each barrier including elongate phase-isolating portions which extend longitudinally between adjacent ones of the bus bars and mesh with complementarily shaped phase-isolating portions of the other barrier to form gas movement impeding labyrinths between said bus bars.

2. A control center according to Claim 1, characterized in that one phase-isolating portion of each meshing pair is a rib formed on one of said barriers and protruding toward the other barrier, and the other phase-isolating portion of the same pair is a channel which is formed in said other barrier and is open toward said one barrier, said rib being seated in said channel.

3. A control center according to Claim 1 or 2 characterized in that said or each barrier provided with said recesses has formed thereon flanges which are disposed around the respective recesses and project from the barrier so as to shield the parts of bus bar connecting portions exposed in the recesses from accidental contact with persons and objects.

4. A control center according to Claim 1, 2 or 3, characterized in that predetermined integral portions of at least one of said barriers which are aligned with flat surface portions of the respective bus bars are removable and just large enough to expose, when removed, parts of said flat surface portions enabling circuit interrupters with bolt-on type terminal connectors to be secured thereto.

5. A control center according to Claim 4, characterized in that the removable portions are knockout portions each joined to the remainder of the associated barrier through a peripheral section of reduced thickness.

6. A control center according to Claim 4 or 5, characterized in that the or each barrier provided with said removable portions has formed thereon flanges projecting from the barrier and disposed around the respective removable portions.

7. A control centre according to any of the preceding claims, characterized in that the recesses enabling connection of each circuit interrupter have associated therewith a shutter which is biased toward a position in which the shutter covers the recesses associated therewith, and which is movable to an ineffective position in which the associated recesses are unobstructed.

8. A control center according to Claim 7, characterized in that said shutter has associated therewith and is connected to a shutter operating member including a cam portion disposed to be engaged by a circuit interrupter and thereby actuated to effect movement of said shutter to said ineffective position during movement of said circuit interrupter toward the associated recesses.

9. A control center according to Claim 7 or 8, characterized in that said shutter is slideably supported on the barrier having the associated recesses formed therein.

10. A control center according to any of the preceding claims, characterized by at least two pairs of braces which latter extend transversely across said barriers and which pairs are spaced apart in the longitudinal direction of the barriers, the braces of each pair engaging the barriers from opposite sides of the assembly comprising said barriers and the bus bars, and being connected together so as to clamp said assembly firmly therebetween.

11. A control center according to Claim 10, characterized in that one transverse brace of each pair is secured to frame structure forming part of said cabinet.

12. A control center according to Claim 10 or 11, characterized in that the surface of each brace engaging the adjacent barrier conforms substantially to the profile of said barrier so as to make full surface contact with the latter throughout its width.

13. A control center according to Claim 10, 11 or 12, characterized in that said braces are formed of steel.

14. A control center according to any of the preceding claims, characterized in that said barriers are substantially identical in configuration.

15. A control center according to any of the preceding claims, characterized in that said barriers consist of a dielectric material comprising of thermosetting resin.

16. A control center according to Claim 15, characterized in that said thermosetting resin is filled with an inorganic reinforcing material.

17. A control center according to Claim 16, characterized in that said reinforcing material is glass fiber.

18. A control center according to Claim 15, 16 or 17, characterized in that said thermosetting resin contains a filler selected from the group consisting of alumina, aluminum hydroxide, beryllium oxide, calcium carbonate, mica, silica, talc, and mixtures thereof.

19. A control center according to claim 1 and substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

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Printed for Her Majesty's Stationery Office by MULTIPLEX techniques ltd., St. Mary Cray, Kent. 1979. Published at the Patent Office, 25 Southampton Buildings, London WC2 1AY, from which copies may be obtained.

1554645 COMPLETE SPECIFICATION

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Sheet 1

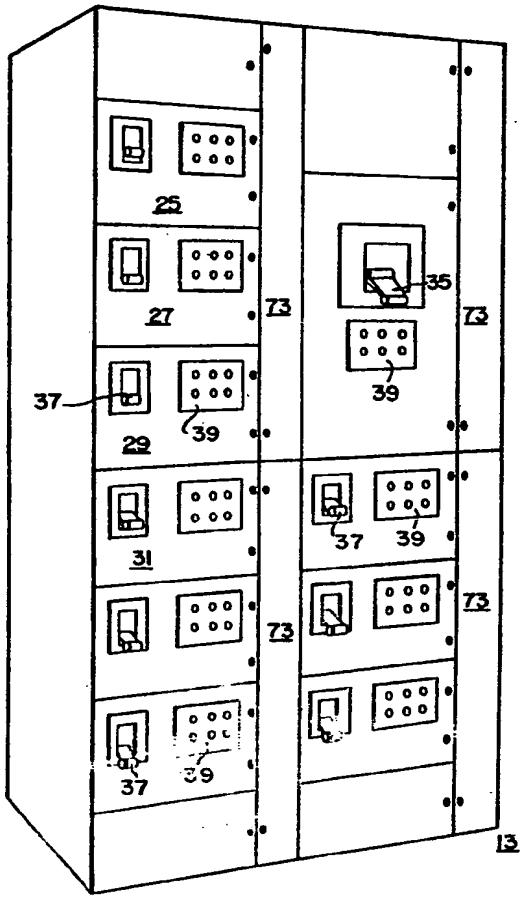

FIG.1

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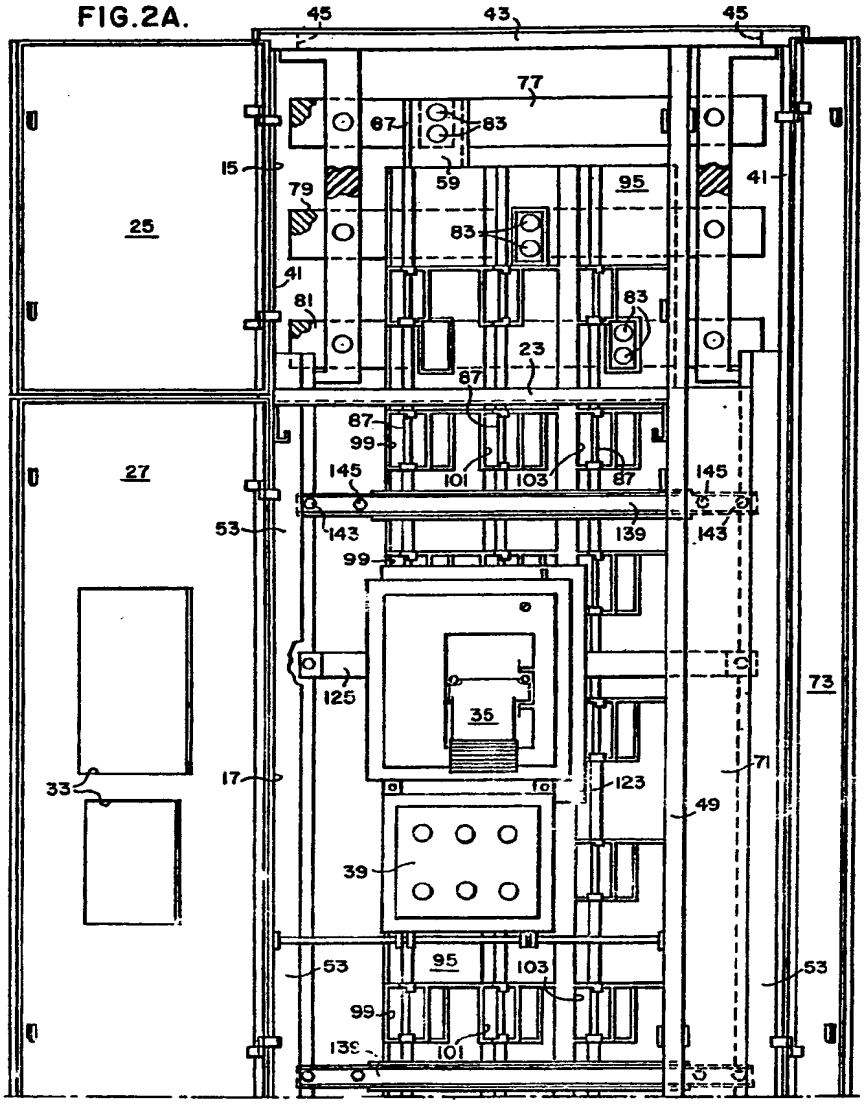
FIG.2A.



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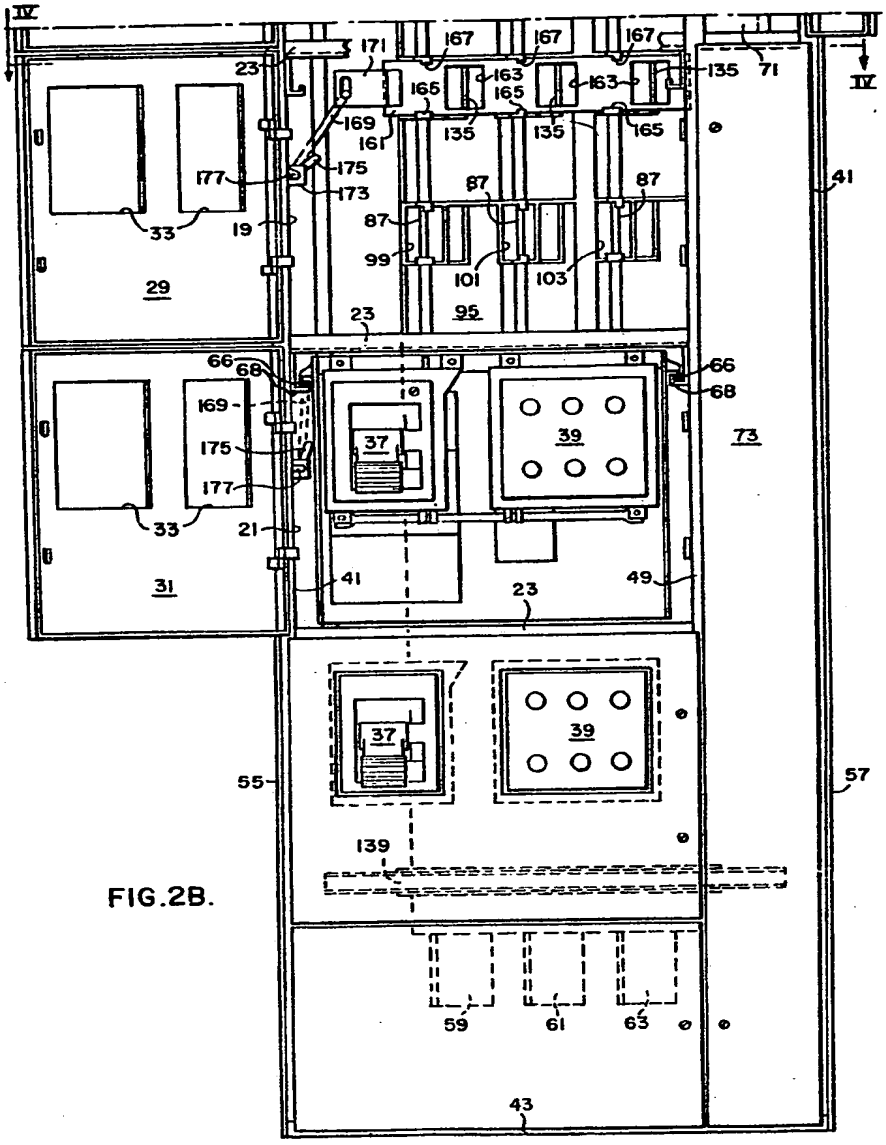

FIG.2B.

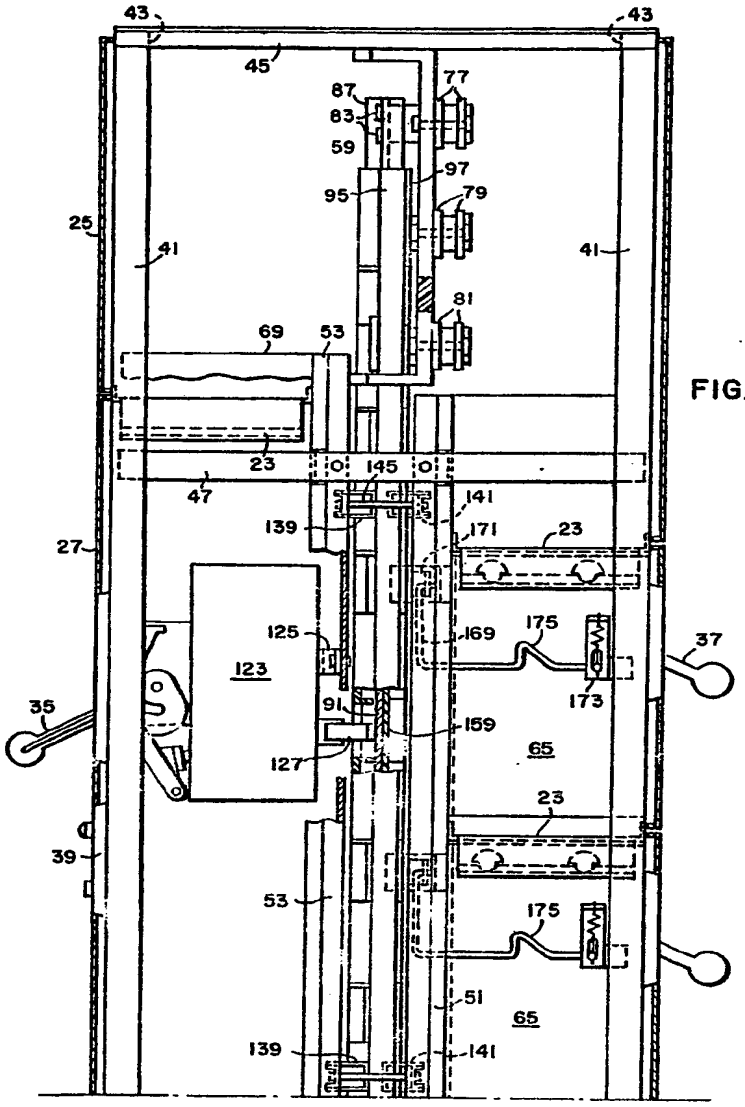
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FIG.3A.

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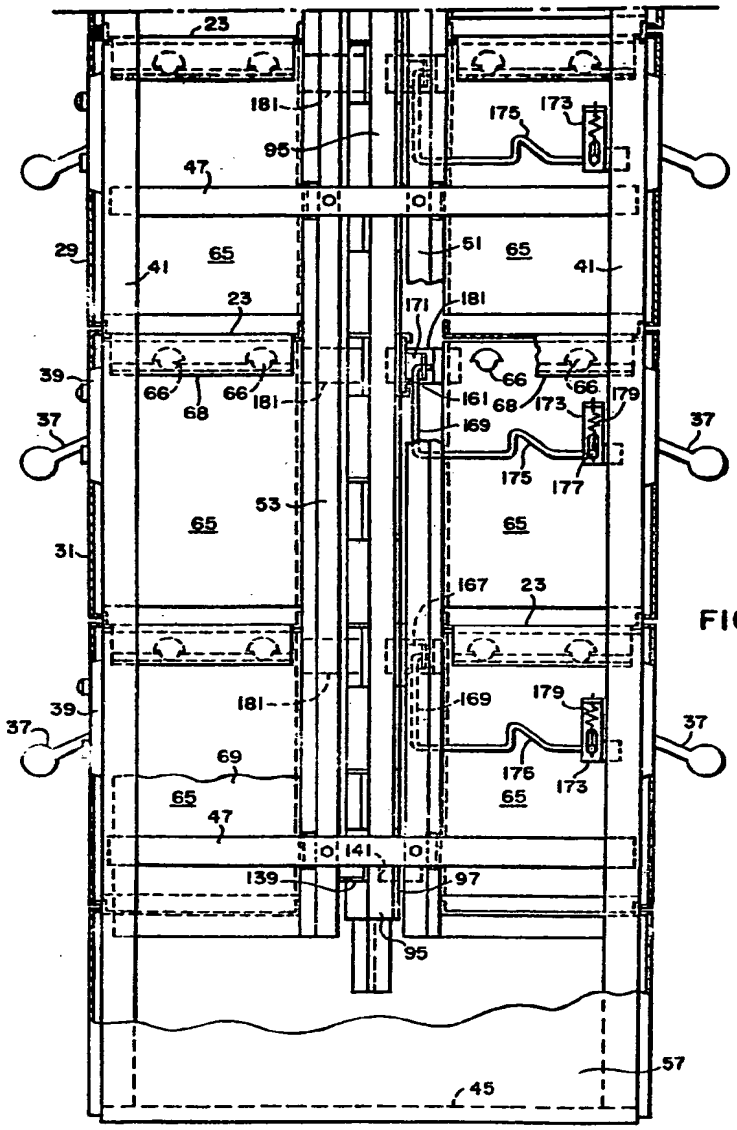

FIG.3B.

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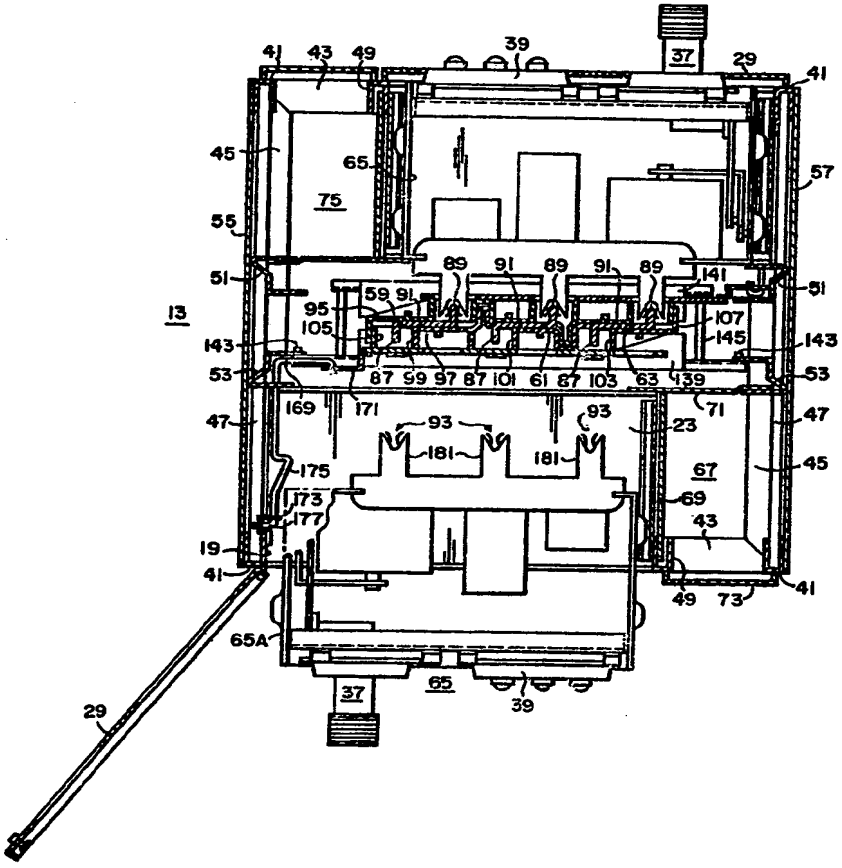
FIG. 4.



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Sheet 7

FIG.5A.

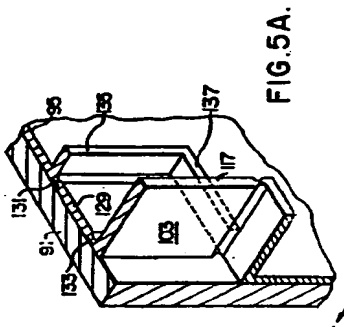

FIG.5

1554645 COMPLETE SPECIFICATION
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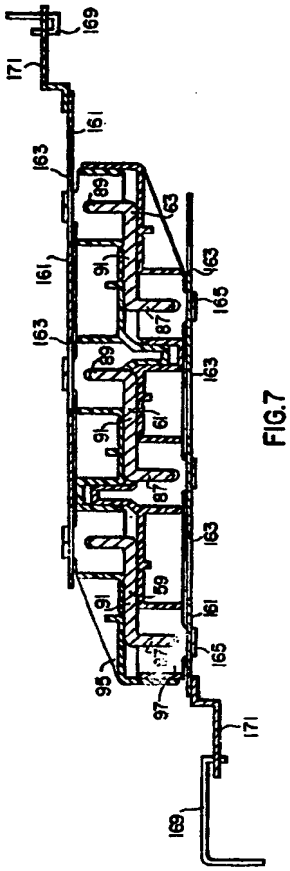

FIG.7

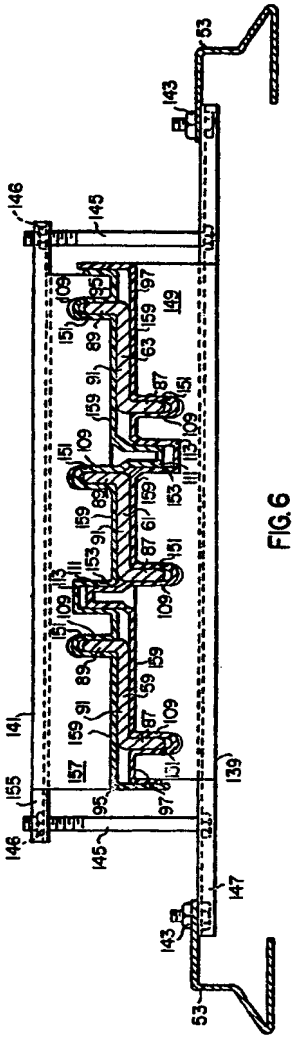

FIG.6